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(54) Detector for flammable gases

(57) A catalytic detector element for flammable gases comprises contact areas 5, 6 on either side of a zig-zag strip-form heater 4 which is coated with catalyst pad or bead 7. Current is passed through the heater in the usual way and a flammable gas is detected by combustion in the catalytic bead 7 thus raising the temperature of the heater and changing its resistance. Prior heater coils were fragile but the heater 4 and contacts 5 and 6 are photolithographically deposited in plantinum on a layer 2 of silicon nitride (or oxide) on a silicon chip, overcoming this problem. To assist thermal isolation of the heater an air gap 9 is formed beneath the silicon nitride by etching through minute perforations which have been themselves etched in the silicon nitride layer. The bead 7 may be of alumina containing a catalyst.

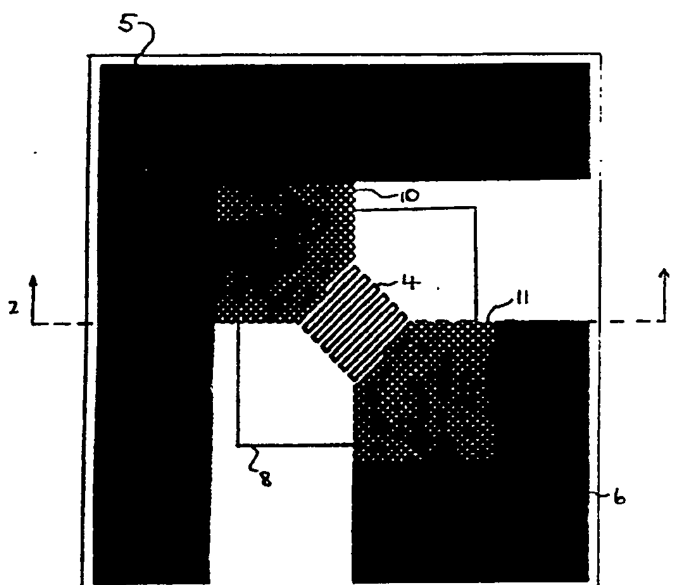

Fig. 1

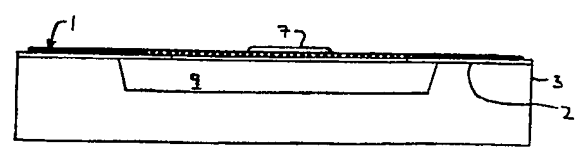

Fig. 2

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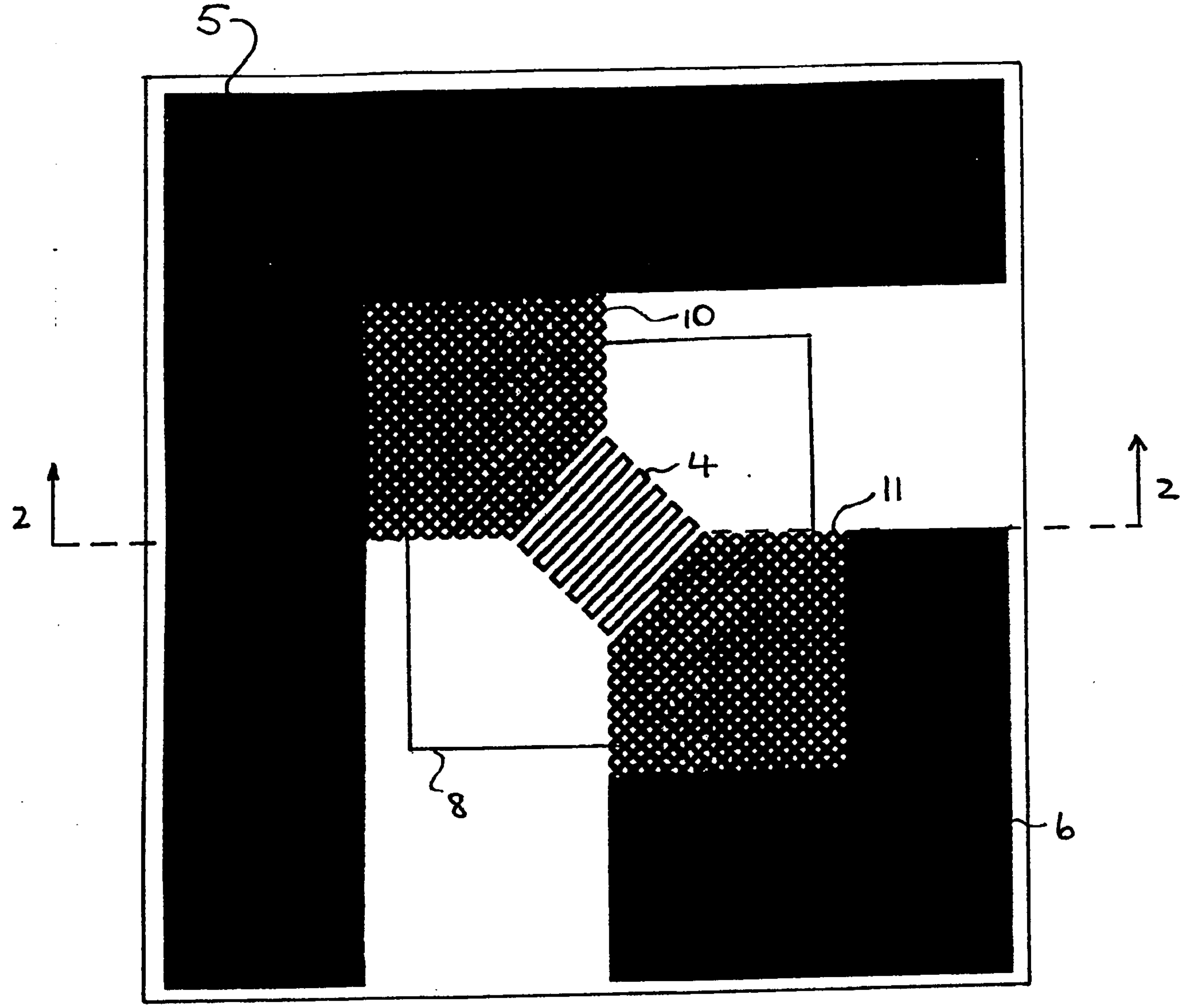

Fig. 1

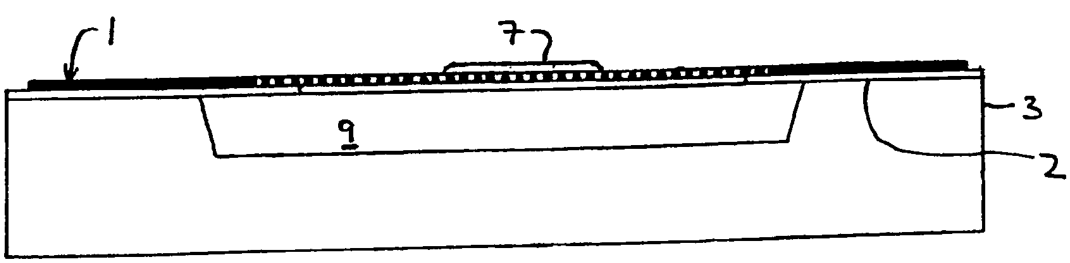

Fig 2.

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Detectors for Flammable Gas

This invention relates to detectors for flammable gas.

The common form of such detector is known as a pellistor and comprises a small coil, often of platinum, around which is deposited a porous bead which acts as a matrix to support the catalyst. In use, the bead is maintained at an appropriate temperature for a catalytic reaction to take place: typically this will be around 450°C - 500°C and the temperature is achieved by passing current through the coil. When a flammable gas is present, it diffuses into the bead and reacts catalytically. The reaction gives out heat which raises the temperature of the bead. The temperature rise is detected as a change in the resistance in the coil.

A problem which such pellistors is that, to reduce the power consumption of the detector, the resistance of the wire is maximised, but this leads to very fine heating wire, which makes the device fragile. Consequently it is difficult to fabricate pellistor-based detectors suitable for operation with

small sized disposable batteries.

The invention provides a detector for flammable gas comprising a conductor, the resistance of which changes with temperature, a catalyst being associated with the conductor, and the conductor being a layer deposited on a substrate.

The use of a deposited layer as the conductor enables a desirable high resistance to be attained without the detector becoming fragile.

Advantageously, the substrate is a membrane, which may be but is not limited to , silicon, or a silicon compound formed as a deposited layer on a silicon chip and etched to form a space between the silicon compound layer and the adjacent face of the silicon chip. The silicon compound layer may be perforated for this purpose.

The associated signal detection and power stabilisation circuits may be integrated economically into the silicon chip using standard integrated circuit techniques.

The invention also provides a method of fabricating a detector for flammable gas, which comprises depositing a layer of conductor, the resistance of which changes with temperature, onto a substrate, the layer of conductor being associated with a catalyst.

A gas detector constructed in accordance with the invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a detector element; and

Figure 2 is a section taken on the lines 2-2 of Figure 1.

The gas detector comprises the detector element shown and a power supply which is not shown.

The detector element comprises a thin film of platinum or other suitable conducting material indicated generally by the reference numeral 1 deposited on a layer of silicon nitride 2 which is itself deposited on a silicon chip 3. The platinum film defines a heater track 4 of zig-zag form xtending between two contact

areas 5,6. A flat pad or bead 7 of alumina containing a catalyst is deposited on top of the heater element.

The detector element is fabricated starting with the silicon chip 1 in the following way. First of all, the layer of silicon nitride 2 is deposited on top of the silicon chip. Next, a layer of platinum 1 is deposited on top of the silicon nitride: this could be done by sputtering. A photolithographic process is then used to produce the configuration of platinum film shown in Figure 1 i.e. the platinum film is coated with photo-resist, exposed to light through a mask with the appropriate pattern, and etched after the appropriate areas have been dissolved away, the photo-resist then being removed to leave the conductor pattern shown in Figure 1.

In order to form the air gap, a second photolithographic process is used to form minute perforations in the silicon nitride in the area of the square 8, in the region of the silicon nitride which is <u>not</u> coated with platinum. Then an etchant is applied to the perforated silicon nitride to etch away a layer of silicon beneath the silicon nitride in the region of the square. Because the silicon is isotropic, the etching

proceeds uniformly in all directions and the silicon area beneath the platinum conductor, as well as in the silicon area elsewhere below and to the side of the square 8, are etched away. Thereafter, the layer of alumina containing the catalyst is screen printed or deposited by some other means over the region of the heater.

The heater 4 is isolated thermally from the contact areas 5,6, firstly, because it is mounted on the silicon nitride film of poor thermal conductivity, secondly, because it is positioned over the air gap 9 produced by etching away the silicon beneath the silicon nitride, and thirdly because that portion of the area of the contacts 5,6 which overlies the air gap is itself perforated (the regions 10, 11).

The device is used by connecting the contact areas 5,6 to a suitable power supply in order that the heater 4 reaches a temperature of around 450°C - 500°C. When the heater is positioned in a flammable atmosphere, the atmosphere diffuses into the bead 7 and reacts catalytically, so raising the temperature of the heater. This in turn changes its resistance. This can be sensed for example as an imbalance in a Wheatstone bridge

circuit of which the heater forms one arm. A suitable indicator is provided to indicate when flammable atmosphere is present.

Because the heater is thin in section and the tracks are narrow, the resistance of the heater is large and sufficient power to raise the heater to operating temperature can be provided by batteries. It is also important that the heater is thermally isolated as described above to ensure that the heat from the hot spot created by the heater and bead does not become conducted away too rapidly into the remainder of the chip.

Because the detector element is fabricated out of a single chip using silicon integrated circuit processing, it would be a simple matter to incorporate current stabilisation and detection circuitry into the silicon material, thereby simplifying the manufacture of the detector.

A suitable size for the detector would be about 3mm square.

Of course, variations may be made without

departing from the scope of the invention, for example, the porous bead could be applied in a different method from screen printing and/or at a different stage of fabrication (e.g. before etching the air gap), other materials could be used for the conductor in place of platinum, and it could be applied by techniques other than sputtering, and equally, oxides of silicon could be used in place of silicon nitride. Also, a variety of catalysts could be used in the porous bead, and materials other than alumina could be used for the bead. The size of the detector may vary markedly from 3mm of side to suit the application in use.

CLAIMS

1. A detector for flammable gas comprising a conductor, the resistance of which changes with temperature, a catalyst being associated with the conductor, and the conductor being a layer deposited on a substrate.

2. A detector as claimed in claim 1, in which the conductor is on a membrane separated from adjacent surfaces of the device.

3. A detector as claimed in claim 2, in which a region between the membrane and the adjacent surfaces is etched away.

4. A detector as claimed in claim 2 or claim 3, in which the membrane is a layer of silicon nitride.

5. A detector as claimed in claim 4, in which the membrane is perforated to enable the etching to take place.

6. A detector as claimed in any one of claims 1

to 5, in which the conductor is formed photolithographically.

7. A detector for flammable gas substantially as herein described with reference to the accompanying drawings.

8. A method of fabricating a detector for flammable gas, comprising depositing a layer of conductor, the resistance of which changes with temperature, onto a substrate, the layer of conductor being associated with catalyst.

9. A method as claimed in claim 8, in which the substrate is a layer of silicon compound deposited on silicon, and a region of the silicon adjacent to the silicon compound is etched away through perforations in the layer of the silicon compound.

10. A method of fabricating a detector for flammable gas substantially as herein described.

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